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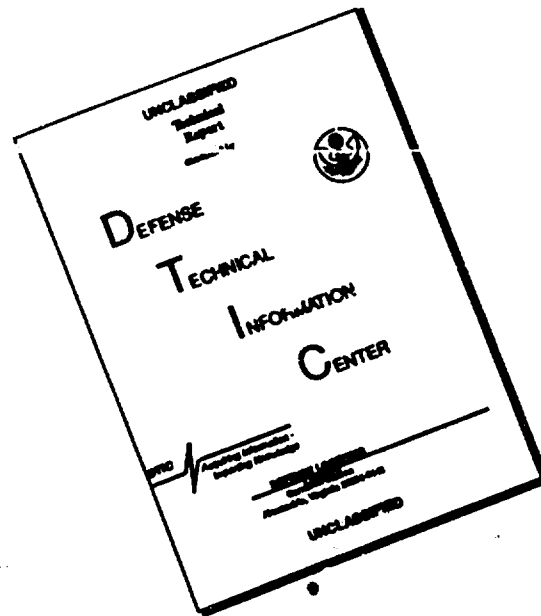
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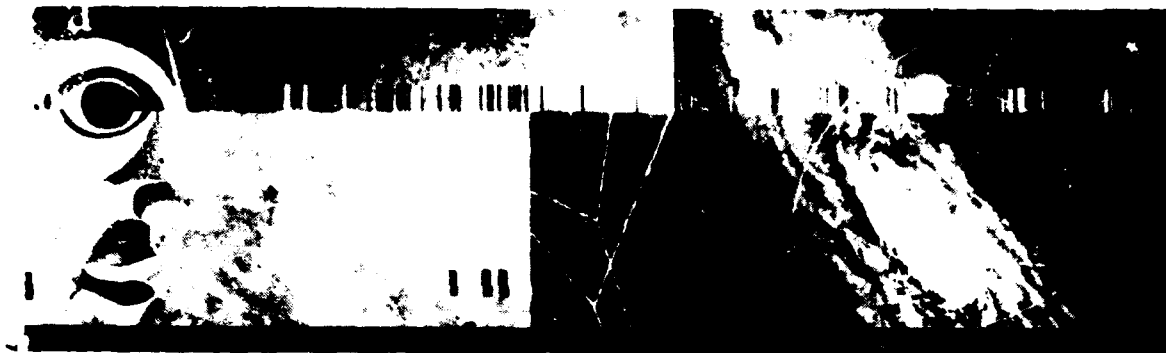
LOCKHEED MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION
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COMPILED BY W. A. KOZUMPLIK

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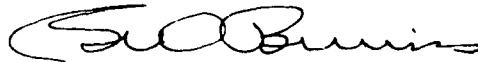
LOCKHEED MISSILES & SPACE COMPANY
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION
BUNNYVALE CALIFORNIA

FOREWORD

These published works provide a window to the Company's capabilities and they are a testimony to our concern for transfer of useful information to the world's scientific and engineering community.

All items listed are available in the libraries - books on shelves and journal articles collected in the compendium entitled "LMSC Authors in Print: 1970." Some titles published prior to 1970 are also listed; these were not received in the Technical Information Center in time for listing last year.

Reprints of journal articles normally are available directly from the authors thereof.

A handwritten signature in dark ink, appearing to read "S. W. Burriss". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

S. W. Burriss, President
Lockheed Missiles & Space Company

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PHYSICAL SCIENCES

The Physical Sciences Laboratory conducts basic and applied research in nuclear physics, space physics, astronomy, atomic physics, electronics and electro-optics. Nuclear physics activities are directed toward understanding the properties of nuclei, their energy levels, lifetimes, and reaction cross sections. The areas of interest for space physics research extend from the upper atmosphere outward and include the ionosphere, the magnetosphere, the interplanetary medium, and finally the interstellar region of deep space. In all these areas a vigorous experimental program using rockets and satellites is being carried out. The current interests in atomic physics are such basic properties of atoms and molecules as the energies of the excited states, the probabilities of transitions between levels, and the cross sections for excitation either by photons or by collisions with other particles. Both theoretical and experimental work on these topics are being accomplished. In electronics and electro-optics, new and improved methods of obtaining, analyzing, and transmitting information are devised. A major effort is devoted to developing the electronic and optical concepts suitable for wideband laser communication systems. The health of the research program in the Physical Sciences Laboratory in 1970 is demonstrated by the following list of publications.

1. ACTON, L. W. (with R. C. Catura, J. L. Culhane, and P. C. Fisher), "X-Ray Line Emission From Scorpius X-1," *Astrophys. J.* 161, L175-L179.
2. _____ (with R. C. Catura, P. C. Fisher, and T. Roethig), "X-Ray Photometry of M1," *Publications of the Astronomical Society of the Pacific* 82, 653-659.
 _____ See 12.
3. ANDERSON, E. E. (with J. L. Weaver), "Demountable Excitation Unit for Cathodoluminescent Spectroscopy," *Applied Spectroscopy* 24, 91-94.
4. _____ (with W. P. Cox and J. H. Anderson, Jr.), "Ultrasonic Aluminum Wire Bonding for Microelectronic Applications," *IEEE Annual Symposium on Reliability*, pp. 228-236.
5. BAKKE, J. C. (with J. B. Reagan, W. L. Imhof, J. D. Matthews, and R. D. Reed), "A High-Sensitivity Particle Spectrometer for the Measurement of Polar-Cap-Absorption Events," *Trans. IEEE Nuc. Sci.* NS 17, 91-96.
 _____ See 42.
6. BATTISTA, A. J., "A Simple, High Performance Linear Gate for Nuclear Physics Applications," *Nucl. Instru. Methods* 80, 172-174.
7. BECKER, J. A. (with R. E. McDonald and A. R. Poletti), "Angular-Correlation Study of Na^{23} Using the $\text{Mg}^{24}(\text{t}, \gamma)\text{Na}^{23}$ Reaction," *Phys. Rev. C* 2, 964-974.
8. _____ (with R. E. McDonald, L. F. Chase, and D. Kohler), "Low-Lying Levels in Na^{25} ," *Phys. Rev.* 188, 1784-1791 (1969).
9. _____ (with T. R. Fisher, A. D. W. Jones and T. T. Bardin), "Properties of the 5.256-MeV State in Si^{29} : Evidence for a Rotational Band With $K\pi = 7/2 - ^+$," *Phys. Rev. Letters* 24, 772-775.
 _____ See 31, 32, 38.
10. BUCHANAN, R. A. (with K. A. Wickersheim), "Position of the Energy Levels of Trivalent Rare-Earth Activator Ions Relative to the Electronic Energy Bands of Lanthanum Oxysulfide: A New Picture of Excitation and Relaxation," *Appl. Phys. Letters* 17, 184-187.
 CAHILL, R. W. See 44, 45.
11. CARROLL, G. A., "The Spar Telescope of Lockheed Solar Observatory," *Sky and Telescope* 40, 10-13.
12. CATURA, R. C. (with L. W. Acton and P. C. Fisher), "Localization of Solar X-ray Emission at Energies Above 4 keV," *Nature* 227, 55-56.
 _____ See 1, 2.

- CHALMERS, R. A. See 52.
13. CHAPPELL, C. R. (with R. K. Burton and C. T. Russell), "The Alfvén Velocity in the Magnetosphere and Its Relationship to ELF Emissions," *J. Geophys. Res., Space Physics* 75, 5582-5586.
 14. _____ (with K. K. Harris and G. W. Sharp), "The Morphology of the Bulge Region of the Plasmasphere," *J. of Geophys. Res., Space Phys.* 75, 3848-3861.
 15. _____ (with K. K. Harris and G. W. Sharp), "The Reaction of the Plasmapause to Varying Magnetic Activity," *Particles and Fields in the Magnetosphere*, pp. 148-153.
 16. _____ (with K. K. Harris and G. W. Sharp), "A Study of the Influence of Magnetic Activity on the Location of the Plasmapause as Measured by OGO 5," *J. Geophys. Res., Space Phys.* 75, 50-56.
 _____ See 23.
- CHASE, L. F., Jr. See 8, 52.
17. CHOW, K. K. (with R. L. Comstock and W. B. Leonard), "1.5 GHz Bandwidth Light Modulator," *IEEE J. Quantum Elec.* QE-5, 618-619 (1969)
 18. CLADIS, J. B. (with G. T. Davidson, W. E. Francis, R. K. Jaggi, G. H. Nakano, and S. L. Ossakow), "Redistribution of Trapped 55-MeV Protons by Starfish Nuclear Explosion," *J. Geophys. Res., Space Phys.* 75, 57-68.
- COMSTOCK, R. L. See 17.
- CULHANE, J. L. See 1.
- DAVIDSON, G. T. See 18.
- FISHER, P. C. See 1, 2, 12.
19. FISHER, T. R. (with D. C. Healey, J. S. McCarthy, and D. Parks), "Experimental Observation of a 'Spin-Spin Effect in the Neutron Total Cross Section of ^{59}Co ," *Phys. Rev. Letters* 25, 117-119.
 _____ See 9.
- FRANCIS, W. E. See 18.
- GAINES, E. E. See 27.
20. GRIFFITH, W. C. (with D. Bershader), "Report on the Seventh International Shock Tube Symposium," *J. Fluid Mech.* 39, 727-734 (1969).
 21. HANČE, H. V. (with C. S. Tsai), "Experimental Investigation of the Resolution Capability of Microwave Ultrasonic-Beam Visualization Techniques Using Bragg Diffraction of a Laser Beam," *J. Acoust. Soc. Am.* 48, 1110-1118.
 22. _____ (with W. I. Dobrov), "Microwave Acoustic Simulation of Airborne Radar Ground Echoes," *IEEE Trans. Microwave Theory and Tech.* MTT-17k, 963-967 (1969).
 23. HARRIS, K. K. (with G. W. Sharp and C. R. Chappell), "Observations of the Plasmapause from OGO 5," *J. Geophys. Res., Space Phys.* 75, 219-224.
 _____ See 14, 15, 16, 34, 41.

24. HERRMANN, G. F. (with R. M. Hill and D. E. Kaplan), "Instability and Echo-Pulse Amplification in a Ferrimagnetic Spin System in an Inhomogeneous Field," *Phys. Rev. B* 2, 2587-2596.
25. _____ (with R. M. Hill and D. E. Kaplan), "Spin-Wave Instability in Nonuniform Fields and the Generation of Amplified Echoes," *J. Appl. Phys.* 41, 925-926.
 _____ See 26.
26. HILL, R. M. (with D. E. Kaplan, G. F. Herrmann and S. K. Ichiki), "Antiferromagnetic Echoes in CsMnF_3 ," *J. Appl. Phys.* 41, 929-931.
 _____ See 24, 25.
 ICHIKI, S. K. See 26.
27. IMHOF, W. L. (with E. E. Gaines and J. B. Reagan), "High-Resolution Studies of Electrons 25 keV to 2.7 MeV Precipitating at High Latitudes," *J. Geophys. Res., Space Phys.* 75, 776-782.
 _____ See 5, 43.
28. JOHNSON, H. M., "Non-solar Gamma and X-ray Astronomy: Optical Observations," *International Astronomical Union Symposium No. 37*, pp. 151-161.
29. _____ (with R. H. Rubin), "Observation and Classification of the Nebula YM 29," *Astrophys. J.* 163, 151-153 (Jan 1971).
30. _____ "The Sky Near the Brightest X-ray Source in Scorpius. II," *Astrophys. J.* 160, 193-197.
 JOHNSON, R. G. See 47.
31. JONES, A. D. W. (with J. A. Becker, R. E. McDonald, and A. R. Poletti), "Beta Decay of Na^{25} and Al^{29} ," *Phys. Rev. C* 1, 1000-1008.
32. _____ (with J. A. Becker and R. E. McDonald), "Study of the Low-Lying Excited States of Al^{29} II: Al^{27} (t, γ) Al^{29} and Si^{30} (t, $\alpha\gamma$) Al^{29} Angular Correlation Investigation," *Phys. Rev.* 187, 1388-1397 (1969).
 _____ See 9.
 KAPLAN, D. E. See 24, 25, 26.
33. KNUDSEN, W. C., "Tropical Ultraviolet Nightglow from Oxygen Ion-Ion Neutralization," *J. Geophys. Res., Space Phys.* 75, 3862-3866.
34. _____ (with G. W. Sharp and K. K. Harris), "Underside Morphology of the F2-ionospheric Layer," *J. Atmos. Terres. Phys.* 32, 1183-1190.
 KOHLER, D. See 8, 38, 52.
35. KULANDER, J. L., "A Comparison of Electron Impact Ionization Rates for N and O Ions," *J. Quant. Spectrosc. Radiat. Trans.* 10, 299-303.
 LEONARD, W. B. See 17.
 MATTHEWS, J. D. See 5, 42.

36. McCORMAC, B. M., "Graduate Education Troubles," Am. Geophys. U. 51, 522-524.
37. _____ ed., Particles and Fields in the Magnetosphere, D. Reidel Publishing Co., 453 pp.
Mc DONALD, R. E. See 7, 8, 31, 32, 38.
NAKANO, G. H. See 18.
38. NIGHTINGALE, R. W. (with J. A. Becker, R. E. McDonald, and D. Kohler), " $O^{18}(t, p_1 \gamma)O^{20}$ Angular Correlation," Phys. Rev. C 1, 893-895.
39. NOBLES, R. A. (with E. B. Hughes and C. J. Wolfson), "Empirical Response Functions for a Neutron Multiplicity Monitor," J. of Geophys. Res., Space Phys. 74, 6459-6470 (1969)

See 55.
40. OSSAKOW, S. L. (with E. Ozizmir and C. H. Su), "Comments on Nonlinear Interaction of Electromagnetic Waves in a Cold Magnetized Plasma," Phys. Fluids 13, 1420-1422.
41. _____ (with G. W. Sharp, and K. K. Harris), "Spectrometer Observations in the Region Near the Bow Shock on March 12, 1968," J. Geophys. Res., Space Phys. 75, 6024-6036.

See 18.
RAMSEY, H. E. See 49.
42. REAGAN, J. B. (with R. D. Reed, J. C. Bakke, and J. D. Matthews), "A Data-Handling System for Large-Scale Space Radiation Experiments," Nuclear Electronics Symposium, pp. 225-229 (1969).
43. _____ (with W. L. Imhof, "Observations on the East-West Asymmetry of Protons Trapped at Low Altitudes," COSPAR Twelfth Plenary Meeting, pp. 853-860 (1969).

See 5, 27.
44. RILEY, J. F. (with R. W. Cahill), "Absorption Spectrum of the Ozone Precursor," J. Chem. Phys. 52, 3297-3298.
45. _____ (with R. W. Cahill), "Emission Observed in The Pulse Radiolysis of Gaseous Nitrogen," Rad. Res. 43, 255.
ROETHIG, T. See 2.
46. SEARS, R. D., "Low-Latitude Ionospheric High-Frequency Doppler Dispersion Study," Radio Sci. 5, 1147-1152.
SHARP, G. W. See 14, 15, 16, 23, 34, 41.
47. SHARP, R. D. (with E. G. Shelley, R. G. Johnson and G. Paschmann), "Preliminary Results of a Low-Energy Particle Survey at Synchronous Altitude," J. Geophys. Res., Space Phys. 75, 6092-6101.
SHELLEY, E. G. See 47.

48. SMITH, S. F. (with D. C. Martin and G. A. Chapman), "The Lockheed-Aerospace Eclipse Expedition," Nature 226, 1138-1139.
 49. _____ (with H. E. Ramsey and B. N. Nolan), Solar Filtergrams of the Lockheed Solar Observatory, Rapid Blue Print Co. 80 pp.
 50. VARNEY, R. N., "Longitudinal Diffusion Coefficients Misnamed," Phys. Rev. Letters 24, 843-844.
 51. _____ "Monatomic and Diatomic Ions in Oxygen," Phys. Rev. A 2, 370-378.
 52. VAUGHN, F. J. (with R. A. Chalmers, D. Kohler, and L. F. Chase, Jr.), "Cross Sections for the $^7\text{Be}(p,\gamma)^8\text{B}$ Reaction," Phys. Rev. C 2, 1657-1665.
 53. WALT, M., "Radial Diffusion of Trapped Particles," Particles and Fields in the Magnetosphere, pp. 410-415.
 54. WARD, R. B. (with F. L. Strubel), "Precision Earth-to-Satellite Range Measurements Using Delay-Lock Techniques," Trans. IEEE Instr. Meas. 1M-19, 118-124.
- WEAVER, J. L. See 3.
55. WOLFSON, C. J. (with R. A. Nobles), "Brief Reports, Threshold Rigidity Change During the Magnetic Storm of March 23-24, 1969," J. Geophys. Res., Space Physics 75, 5553-5558.
- _____ See 39.

ENGINEERING SCIENCES

Research within the Engineering Sciences Laboratory covers such fields of endeavor as thermophysics, fluid mechanics, solid and analytical mechanics, mathematics, astrodynamics, and underwater acoustics. Thermal energy transfer, cryogenics, thermal control, and space environmental effects on space vehicles are subjects of immediate concern of thermophysics. Fluid mechanics research is oriented toward exploring the physics of planetary reentry as well as investigating the characteristics of disturbed airflow environment around hypervelocity vehicles. The extreme constraints of reliability and weightsaving imposed upon aerospace vehicles make it imperative that the **analytical prediction of their mechanical response**, such as stresses, deformations, and failure mode, be as **realistic as possible**. Solid and analytical mechanics solve these problems through research in both their theoretical and experimental phases. Current research in mathematics at LMSC covers **statistics**, numerical analysis, and differential equations. The **astrodynamics research deals with flight performance**, navigation, guidance, and the development of new tools and techniques for solving astrodynamical problems. The following list of open-literature publications may be taken as a measure of the depth of research conducted by the Engineering Sciences Laboratory.

56. ALMROTH, B. O. (with L. H. Sobel and A. R. Hunter), "An Experimental Investigation of the Buckling of Toroidal Shells," J. AIAA 7, 2185-2186 (1969).
57. _____ (with A. B. Burns and E. V. Pittner), "Design Criteria for Axially Loaded Cylindrical Shells," J. Space. Rock. 7, 714-720; also in AIAA-ASME Structures, Structural Dynamics and Materials Conference Proceedings, pp. 173-184.
 _____ See 61. 87.
58. BANDEL, H. W. (with A. D. MacDonald), "Microwave Breakdown in Air Plus H_2O ," J. Appl. Phys. 41, 2903-2905.
59. _____ (with A. D. MacDonald), "Transition from Free to Ambipolar Diffusion," International Conference on Phenomena in Ionized Gases, p. 427 (1969).
60. BLAKE, L. H., "Approximate Transport Calculations for High-Temperature Air," J. AIAA 8, pp. 1698-1701.
 _____ See 68.
61. BROGAN, F. (with B. O. Almroth), "Buckling of Cylinders with Cutouts," J. AIAA 8, pp. 236-240.
 BURNS, A. B. See 57.
62. BUSHNEIL, D., "Analysis of Buckling and Vibration of Ring-Stiffened, Segmented Shells of Revolution," Int. J. Solids Structures 6, pp. 157-181.
63. _____ "Analysis of Ring-Stiffened Shells of Revolution Under Combined Thermal and Mechanical Loading," AIAA-ASME Structures, Structural Dynamics and Materials Conference Proceedings, pp. 196-210.
64. _____ (with S. C. Batterman), "Asymptotic Analysis for Axisymmetric Buckling of Axially Compressed Short Cylinders With Free Edges," J. Appl. Mech. 36, pp. 329-330 (1969).
65. _____ "Buckling and Vibration of Ring-Stiffened, Segmented Shells of Revolution: Numerical Results," Pressure Vessel Technology Conference, pp. 255-268 (1969).
66. _____ "Computer Analysis of Complex Shell Structures," J. Space. Rock. 7, pp. 439-445.
67. _____ "Nonlinear Analysis for Axisymmetric Elastic Stresses in Ring-Stiffened, Segmented Shells of Revolution," AIAA-ASME Tenth Structures, Structural Dynamics and Materials Conference Proceedings, pp. 104-113 (1969).
68. CHOU, Y. S. (with L. H. Blake), "Energy-Momentum Coupling in Radiating Shock Layers About a Blunt Body," J. AIAA 8, 1680-1686.
 CUFF, K. F. See 89, 90.
69. CUNNINGTON, G. R. (with C. L. Tien), "A Study of Heat-Transfer Processes in Multilayer Insulations," Progress in Astronautics and Aeronautics, Vol. 23, pp. 111-126.

70. DICKSON, R. J. (with L. M. Perko), "Bounded Quadratic Systems in the Plane," J. Different. Eq. 7, 251-273.
71. DOBROV, W. I. (with E. R. Washwell), "CO₂ Laser Pumping by a dc-Tesla Coil Combination," J. Appl. Opt. 9, p. 1485.
____ See 22.
72. FORSBERG, K. J., "Exact Solution for Natural Frequencies of Ring-Stiffened Cylinders," AIAA-ASME Tenth Structures, Structural Dynamics and Materials Conference Proceedings, pp. 18-30 (1969).
73. GEERS, T. L., "Response of an Elastic Cylindrical Shell to a Transverse Acoustic Shock Wave in a Light Fluid Medium," J. Acoust. Soc. Am. 48, pp. 692-701.
GREENSBURG, S. A. See 79.
HARTOG, J. J. See 77.
HAWKINS, S. R. See 90.
74. HOOKER, W. W., "A Set of r Dynamical Attitude Equations for an Arbitrary n-Body Satellite Having r Rotational Degrees of Freedom," J. AIAA 8, pp. 1205-1207.
75. HUNTER, A. R., "Photoelasto-Plastic Analysis of Notched-bar Configuration Subjected to Bending," Exptl. Mech. 10, pp. 281-287.
____ See 56.
76. KHABBAZ, G. B., "Comparison of Mechanical Coupling Factor by Two Methods," J. Acoust. Soc. Am. 47, pp. 392-393.
77. KNOLLMAN, G. C. (with J. J. Hartog), "Local Field of an Acoustic Source in a Submarine Canyon," J. Acoust. Soc. Am. 48, 729-738.
78. MARLOW, W. C., "Approximate Lasing Condition," J. Appl. Phys. 41, 4019-4022.
79. McCARGO, M. (with S. A. Greenberg and N. J. Douglas), "Radiation-Induced Absorption Bands in Spacecraft Thermal Control Coating Pigments, Progress in Astronautics and Aeronautics, Vol. 23, pp. 189-218.
MURRAY, D. O. See 152.
80. MUSAL, H. M., Jr., "Electrostatic Probe and Electronic Circuit for Low-Temperature Plasma Measurements," J. Appl. Phys. 41, 2605-2609.
81. _____ (with P. D. Thomas and M. Vinokur), "Radar Doppler Spectra of Turbulent Ionized Wakes," IEEE Trans. Aero. Elect. Sys. AES-6, 252-254.
NAKANO, H. H. See 85.
82. NICKELL, E. H., "Weight Considerations for Deep Submersibles," Marine Tech. 7, 196-204.
83. PARKS, J. K., "An Acousto-Optic Receiver and Fast Spectrum Analyzer for Electromagnetic Signals in the VHF-UHF Range," IEEE Trans. Commun. Tech. COM-17, 686-700 (1969).

84. ROLLING, R. E. (with K. N. Marshall), "Scale Modeling of a Multilayer Insulated Spacecraft for Use in a Preliminary Design Study," Progress in Astronautics and Aeronautics, Vol. 23, pp. 437-460.
85. SALOP, A. (with H. H. Nakano), "Total Electron Scattering Cross Section in O₂ and Ne," J. Phys. Rev. A 2, 127-131.
86. SAMUELSON, L. A., "Creep Buckling of a Cylindrical Shell Under Non-Uniform External Loads," Int. J. Solids Struct. 6, 91-116.
87. SMITH, S. (with B. O. Almroth), "An Experimental Investigation of Plastic Flow Under Biaxial Stress," Exptl. Mech. 10, 217-224.
- SOBEL, L. H. See 56.
88. TETENBAUM, S. J. (with S. A. Rosenthal and W. H. Watson), "Millimeter Wave Propagation Through Ablated Dielectric Windows," Symposium on Electromagnetic Windows, pp. 181-186.
- THOMAS, P. D. See 81.
- VINOKUR, M. See 81.
89. WASHWELL, E. R. (with K. F. Cuff), "High-Speed Electrooptic Spectral Scanning," J. Appl. Opt. 9, 1911-1919.
90. _____ (with S. R. Hawkins and K. F. Cuff), "The Nernst Detector: Fast Thermal Radiation Detection," J. Appl. Phys. Letters 17, 164-166.
- _____ See 71.
- WEAVER, J. L. See 3.
91. WOOD, A. D., "Flash Burst Operation of an Electronic Stroboscope," Rev. Sci. Inst. 41, 1091-1092.

MATERIALS SCIENCES

The efforts of the Materials Sciences Laboratory are concentrated in three areas - metallurgy, composite materials, and chemistry. The significant engineering properties of materials depend uniquely upon their structure. Physical properties of metals, alloys, and composite materials are strongly influenced by the interactions of impurities, crystalline imperfections, substructure, and interfaces. Since the interrelationship between structure and properties is basic to metals and composite materials, the Materials Sciences Laboratory undertakes investigations that are concerned with phase equilibria and transformations, diffusion kinetics, plastic deformation, fracture phenomena, and surface effects on mechanical properties. The Chemistry Laboratory activities comprise organic chemistry ranging from synthesis of new polymers and adhesives to kinetic studies and hot atom chemistry, surface chemistry dealing with solid-gas and solid-liquid interface reactions, and general chemistry. The following open literature publications indicate the extent of the research conducted in the Materials Sciences Laboratory.

- ADAMS, G. B. See 136.
92. BAILIN, L. J. (with M. E. Sibert), "New Developments in Refractory Pigments for White Thermal Control Coatings," Thermodynamics and Thermophysics of Space Flight, pp. 191-209.
93. BRADSHAW, W. G. (with M. J. Mitchell), "Scanning Electron Microscopy and Structure of Chemically Vapor Infiltrated Carbon-Carbon Composites," Scanning Electron Microscope Symposium, pp. 369-376.
- CROOKS, D. D. See 132.
94. CROSSLEY, F. A., "Kinetics of Ti_3 Al Grain Boundary Precipitation in Ti-Al Binary and Ti Al-X Ternary Alloys and Correlation with Mechanical Properties," Metal. Trans. 1, 1921-1929.
95. CROSSMAN, F. W. (with A. E. Vidoz, C. G. Ryder and J. L. Camahort), "Mechanical Properties of Nitrided Boron-Aluminum Composites," J. Compos. Mat. 4, 264-272.
- _____ See 101.
96. DeRUNTZ, J. A., Jr., "End Effect Bending Stresses in Cables," J. Appl. Mech. 91, 750-756 (1969).
97. IZU, Y. D. (with R. R. Johnson and M. D. Mazenko), "Graphite/Organic Composites in Structural Spacecraft Panels," Western Space Congress, pp. 958-972.
- KINDER, W. C. See 132.
98. LAVENDEL, H. W. (with G. C. Kuczynski), "Effect of Dispersed Oxide Particles Upon Sintering of Metallic Compacts," Int. J. Powder Metal. 5, 19-26 (1969).
99. ROTHWELL, W. S., "Analysis of Asymptotic Small-Angle X-Ray Scattering Curves," J. Appl. Phys. 41, 4459-4469.
100. _____ (with T. A. Dolton), "Permeability-Strength Relationships in Porous Materials," J. AIAA 8, 740-746.
- SIBERT, M. E. See 92.
101. VIDOZ, A. E. (with F. W. Crossman), "Mechanical Properties of Nitrided Boron-Aluminum Composites," J. Compos. Matl. 4, 264-272.
- _____ See 95.

INFORMATION SCIENCES

Research efforts of the Information Sciences Laboratory are concentrated in three areas: information retrieval, artificial intelligence and picture processing, and interactive systems. The basic laboratory tool in use is the IBM 360/40 computer with large, random access peripheral storage, a variety of input/output devices, and associated software. Input/output devices include both local and remote CRT displays for man-machine communication, and a program-controlled film reader which can be used to convert pictorial and graphic information into machine-readable form.

The focal point of research in information retrieval is the DIALOG system, an interactive retrieval system. Experiments in information systems and models, including management reporting and control systems, library retrieval systems, and business simulation are performed.

The artificial intelligence and picture processing programs are concerned with pictorial and graphical data processing, decision techniques, and automated means for dealing with sensor data. The goal of these research programs is to develop new techniques and to apply them in the automatic screening and man-machine processing of photographic and sensor data.

Finally, the research in interactive systems concerns methods by which a person may interact directly with a computer to describe a problem and to guide the computer toward an acceptable solution. The ALERT system, a general-purpose on-line data management and information retrieval system, is the main vehicle for this research.

The following list of open-literature publications may be taken as a measure of the scope of research conducted by the Information Sciences Laboratory.

102. EARL, L. L., "Experiments in Automatic Extracting and Indexing," *Inform. Stor. Retr.* 6, 313-334.
103. FISCHLER, M. A., "Machine Perception and Description of Pictorial Data," Proceedings of the International Conference on Artificial Language, pp. 629-639. (1969).
104. _____ (with A. Reiter), "Variable Topology Random Access Memory Organization," AFIPS Conference Proceedings, Vol. 34, pp. 381-391 (1969).
Mac DONALD, A. D. See 58.
105. ROBISON, H. R., "Computer-Detectable Semantics Structures," *Inform. Stor. Retr.* 6, 273-288.

ENGINEERING

Current and next generation missiles and spacecraft present engineering problems which draw consistently upon the following technologies: aerodynamics and thermodynamics, biotechnology, guidance and control, imaging and optics, information processing, power and propulsion, structures, and vehicle design and testing. The greater part of LMSC Engineering activity involves these technologies as they apply to missiles, spacecraft, and deep submersibles. Efforts are directed mainly to selected areas associated with the specific systems to be operated.

Parallel to the main concentration of system-oriented activity is a necessary effort in advanced technology which seeks to translate research findings or engineering innovations into practical techniques for missiles, spacecraft, and diversified applications. The 1970 contributions to the open literature reflect this scope of engineering activity and concentration of emphasis.

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STATISTICAL SUMMARY

During 1970, LMSC authors deposited 217 published contributions in the Technical Information Center. Several works were published prior to 1970 but were never deposited heretofore; these are listed. On the other hand, 1970 imprints not received as this booklet goes to press will be listed in next year's brochure.

These publications are statistically summarized here in these categories: publishing medium, funding source, and initiating organization.

<u>Category</u>	<u>1970</u>	<u>1969</u>	<u>1968</u>	<u>1967</u>	<u>1966</u>	<u>1965</u>
Publishing Medium						
Journals or Society Transactions	140	223	197	202	181	239
Symposium or Conference Proceedings	57	58	74	71	19	54
Chapters in Books	11	34	24	17	32	34
Books	<u>9</u>	<u>5</u>	<u>6</u>	<u>6</u>	<u>5</u>	<u>4</u>
Total	217	320	301	296	237	331
Funding Source						
IR/ID*	30	48	46	48	49	65
Contract	39	62	55	44	37	56
IR/ID and Contract	17	18	16	32	22	28
Not Stated	<u>131</u>	<u>192</u>	<u>184</u>	<u>172</u>	<u>129</u>	<u>182</u>
Total	217	320	301	296	237	331
Initiating Organization						
President's Office	1	0	0	0	0	1
Information Processing	1	3	7	5	5	8
Administration	1	1	1	1	1	1
Financial Operations	1	4	3	2	2	3
Operations Services	5	3	6	11	1	5
R&DD	137	266	241	230	211	292
SSD	54	28	29	33	13	13
MSD	<u>17</u>	<u>15</u>	<u>14</u>	<u>14</u>	<u>4</u>	<u>8</u>
Total	217	320	301	296	237	331

*IR/IR - Independent Research/Independent Development Programs sponsored by Lockheed.